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ACD-330-90-01

DME/P FLIGHT TEST RESULTS USING THREE DIFFERENT CLASS DME INTERROGATORS

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DRAFT

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PURPOSE

Evaluate the accuracy and coverage of the Microwave Landing System (MLS) DME/P system using the dual mode E-Systems ground station, two different antennas, and three different class precision DME airborne interrogators.

DISCUSSION

The ongoing effort of demonstration of MLS and MLS RNAV flight operations and procedures provided flight test data for this preliminary examination of DME/P system performance.

EQUIPMENT DESCRIPTION

A dual mode engineering model DME/P ground station manufactured by the Montek division of E-Systems Inc. operating as a stand alone facility was used with two different DME antennas during the tests: an Interscan antenna, designated FA-10109, built specifically for the E-Systems DME/P ground system; and a directional DME/ILS antenna built by CHU Associates, Inc. Separate radial runs were flown on each antenna to determine the suitability of the lower profile CHU antenna, which has a lower physical profile, for use in the height restricted approach lane.

The FA-10109 DME/P antenna is a cylindrical unit, approximately 10 inches in diameter and 12 feet high weighing 82 pounds. It is a biconical type with 12 radiating elements having 360° azimuth and +15° elevation coverage with a peak gain of 6bBi.

The CHU antenna is a cylindrical unit approximately 6 inches in diameter and three feet high weighing 30 pounds. It is a two stacked element directional unit with approximately 8bBi gain in the forward direction. The antenna was tilted away from the approach path approximately 12° as per FAA standard mounting fixture.

The three airborne interrogators used on the tests were all precision DME units but functioned in different modes of operation; DME/N, initial approach (IA) mode only, and dual mode, IA and final approach (FA) mode.

The Honeywell DME unit (DM-850) was designed to meet the IA mode accuracy for precision DME ground stations associated with MLS. It is not capable of FA mode operation and is considered to conform to DME/N operational standards.

The Bendix PDME1 interrogator was designed and built in the early 1980's and meets the recent DME/P specification for IA and FA mode pulse shape, but does not automatically transition to the FA mode and, therefore, is IA mode only operation.

The SEL DME/P 400 interrogator is capable of dual IA and FA mode of operation and meets the DME/P specification.

A Motorola Mini-Ranger provided the reference distance information for post flight processing. The Mini-Ranger System (MRS III), operates on the principle of pulse radar: the transmitter was located on the aircraft to interrogate a reference station, which was mounted on the ground station DME/P antenna support mast. The range, which was recorded in the aircraft, was determined by the measurement of the elapsed time between the airborne interrogation and the reply from the reference station. The reduced data was corrected for differences in MRS III and DME antenna locations both on the ground and in the test aircraft.

The absolute calibration of zero miles for each interrogator was not possible due to the lack of a DME/P bench test set, but previous tests of the PDME1 and the DME/P 400 on a precision simulator showed minimal bias on these units. The DM-850 bias error could not be verified.

RESULTS

The results of constant altitude inbound radials showed that all three interrogators met the $\pm$100 ft. distance error specification, neglecting unaccountable positive bias in the DM-850 unit. The data plots of figure 1 show distance error vs. aircraft distance from the DME/P ground station antenna for each of the three units, recorded on the same run with the Interscan antenna in use on the ground. The filtered distance data output of the PDME1 and DME/P 400 was used in the plots, filtered distance data output is not available on the DM-850. PFE and CMN filtering was not applied. The higher noise content of the DM-850 is evident as compared to the filtered distance output of the other interrogators, with the DME/P 400 having the least. The transition from IA mode to FA mode is apparent on the DME/P 400 at about 8 nmi.

Relative field strength of the DME/P signal at the interrogator input was derived from the calibrated Automatic Gain Control (AGC) of the DME/P 400.

Figure 2 and figure 3 show the relative field strength or pattern of the FA-10109 and CHU antennas respectively. The signal level vs. elevation angle from the DME antenna indicates definite nulls in the pattern for the CHU antenna. Although the deep null at 1.75° is not desirable, it is not critical to the 3° glide path, but a different location or mounting height of the antenna could significantly affect DME operation. The Interscan antenna is preferred if obstruction clearance is suitable.

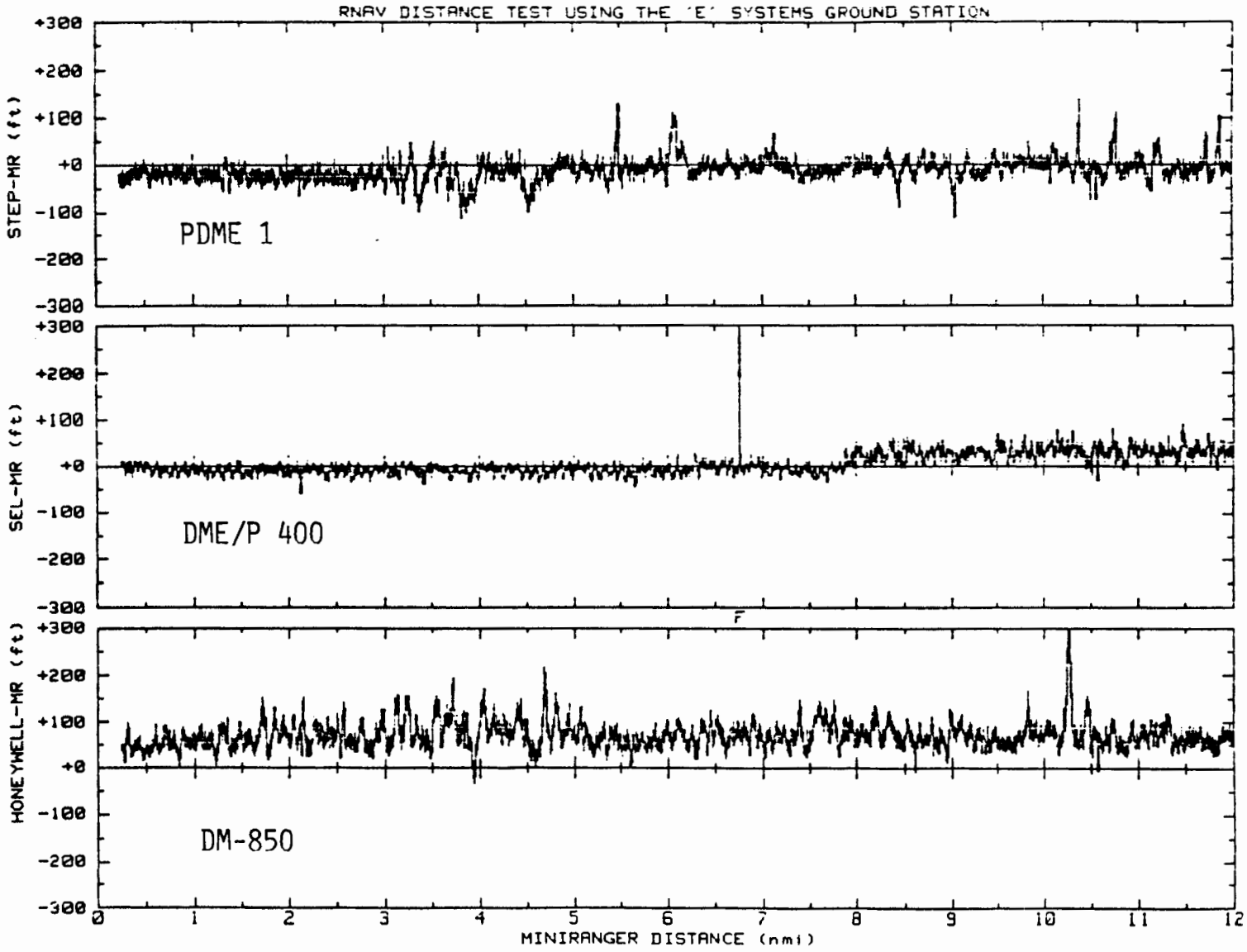

RNAV DISTANCE TEST USING THE 'E' SYSTEMS GROUND STATION
STEP-MR (ft)
+300
+200
+100
+0
-100
-200
-300
PDME 1
SEL-MR (ft)
DME/P 400
HONEYWELL-MR (ft)
DM-850
F
0
1
2
3
4
5
6
7
8
9
10
11
12
MINIRANGER DISTANCE (nmi)

FIGURE 1

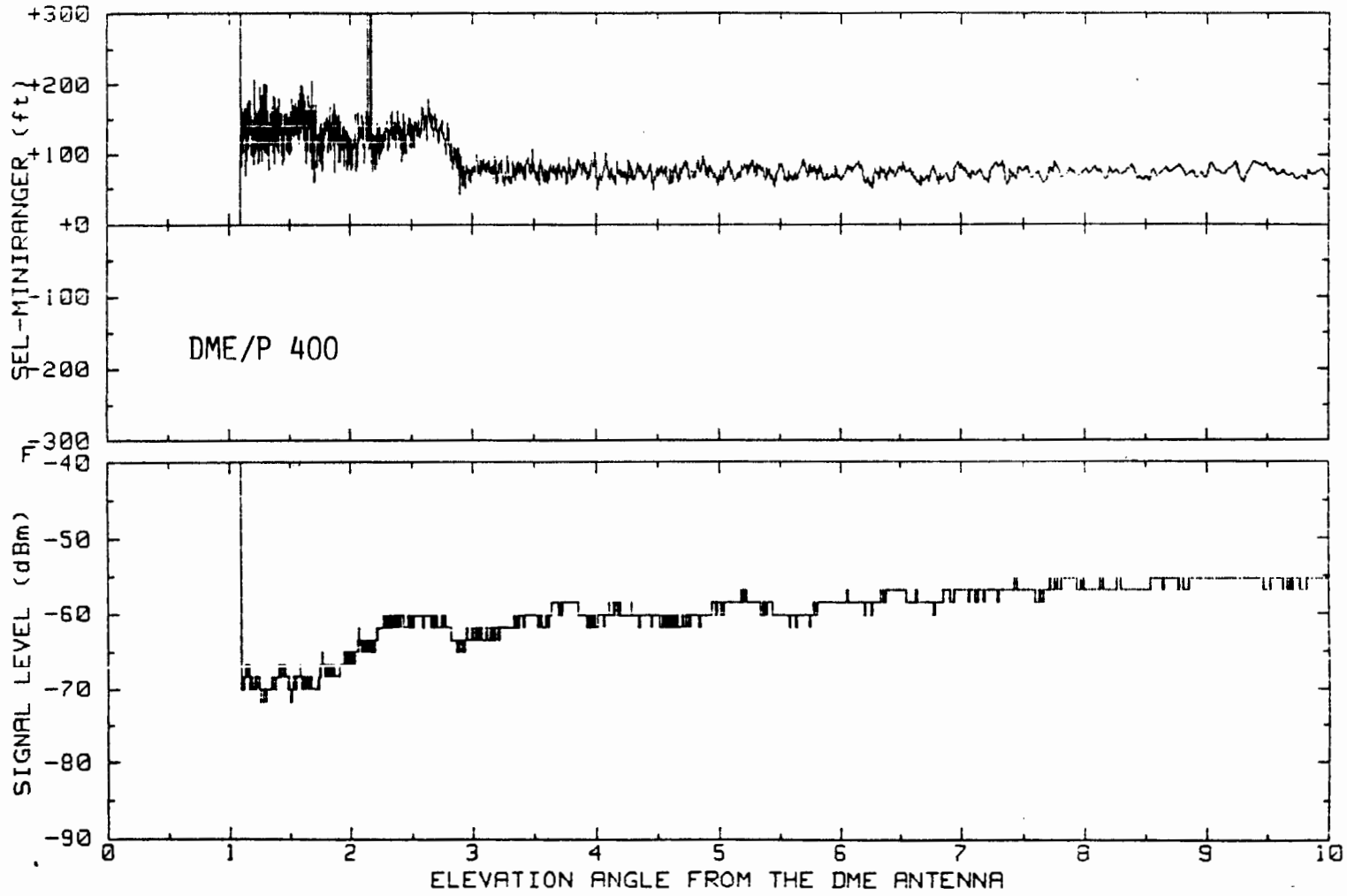


FIGURE 2. FA-10109 RECEIVE PATTERN

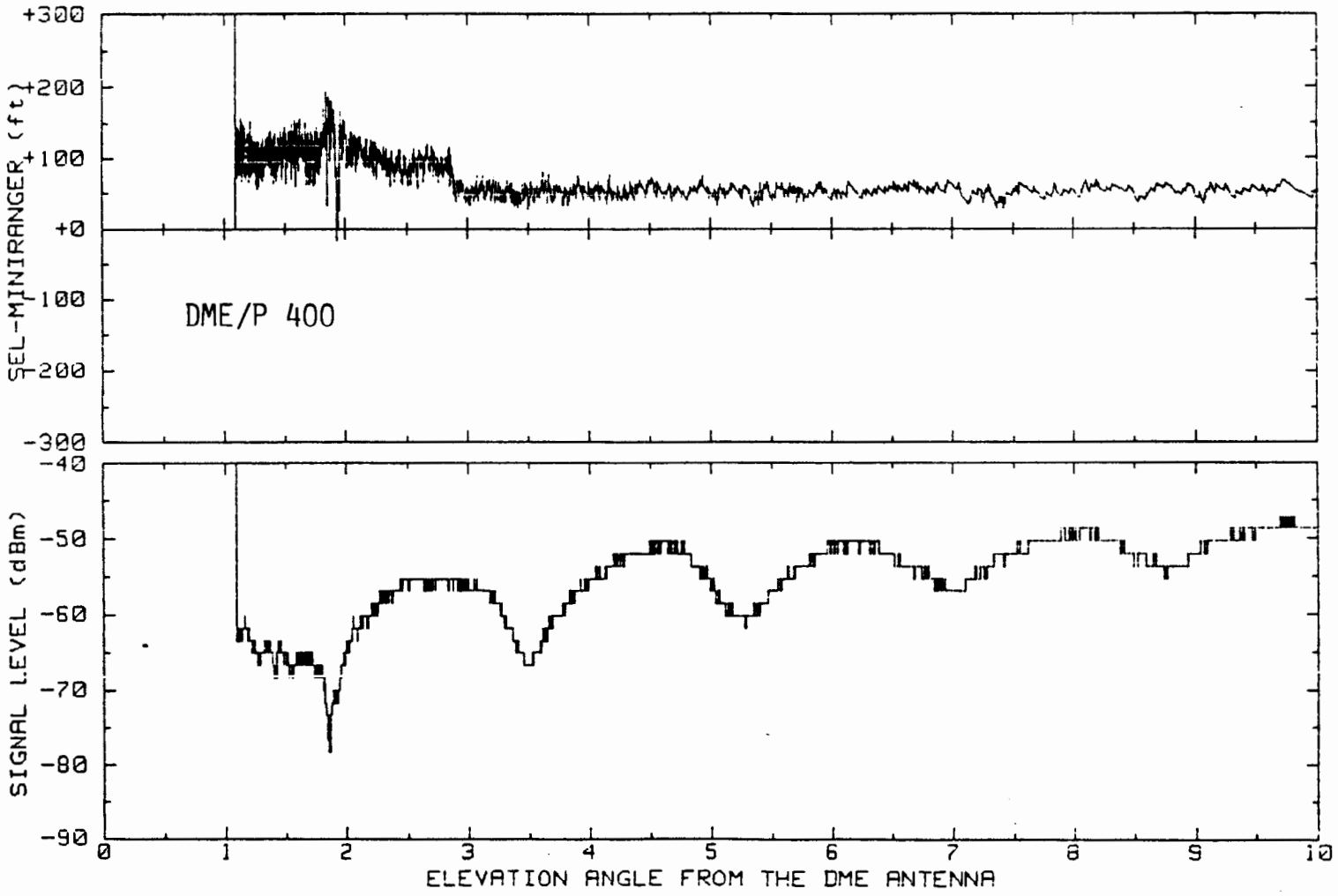


FIGURE 3. CHU ANTENNA RECEIVE PATTERN